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EVALUATION OF BIO-RATIONAL INSECTICIDES FOR ECO-FRIENDLY MANAGEMENT OF LOOPER AND POD BORER OF SOYBEAN

Md. Mahamudul Hasan Manik[1], Ishrat Afreen[1], Md. Ramiz Uddin Miah[1], Md. Ruhul Amin[1] and Md. Shamim Hossain[1]*

[1]Department of Entomology, Gazipur Agricultural University, Gazipur 1706, Bangladesh.

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ABSTRACT

Soybean (*Glycin max*) is high in protein and vegetable oil grown widely globally and nationally. About 15-20% of the total soybean production is lost directly or indirectly by the attack of insect pests every year. The study was conducted during October 2024 to April 2025 in the field and laboratory of the Department of Entomology of Gazipur Agricultural University (GAU), Gazipur to assess some selected bio-rational insecticides against looper and pod borer of Soybean with 6 treatments and 3 replications following randomized complete block design. Biomax 1.2 EC (Abamectin) @ 1 ml/L, Success 2.5 SC (Spinosad) @ 1 ml/L, Biotrin (Matrine 0.5% AS) @ 1.5 ml/L, Bio BTK (*Bacillus thuringiensis kurstaki*) @ 1 g/L, Neem Seed Kernel Extract (NSKE) @ 50 g/L were the key elements of the treatment and an untreated control plot was maintained for comparison. Looper and pod borer were found in the soybean field and those pests were effectively controlled by two sprays of Biomax 1.2 EC (Abamectin), Success 2.5 EC (Spinosad), Biotrin (Matrine 0.5% AS), Bio BTK (*Bacillus thuringiensis kurstaki*) and Neem Seed kernel Extract (NSKE). Among the treatments, the highest percent of pod infestation reduction over untreated control plot was found in Success 2.5 SC (91.6% by n/n) treated plot as well as the highest yield (4.4±1.1 MT/ha) and MBCR (4.6) was recorded with management approach comprising 2 sprays of Success 2.5 SC (Spinosad)@ 1.5 g/L of water. This management approach might be an effective, suitable and viable approach for suppressing looper and pod borer in soybean field.

Keywords: Soybean pests, *Helicoverpa armigera*, Looper, Bio-rational insecticides

INTRODUCTION

Soybean (*Glycine max* L.) is one of the most important leguminous crops (family Fabaceae) which is mainly grown for oil and protein in both the Rabi and Kharif

*Corresponding author: *shamim.ent@gau.edu.bd*

seasons of Bangladesh. Soybean is also recognized as golden bean or miracle bean grows in tropical, subtropical and temperate climates (Yadav *et al*. 2013). Seeds of soybean contain about 42% protein and 20% oil and considerable amounts of dietary fibers, minerals and vitamins which provide 60% of the world supply of vegetable protein and 30% of the edible oil (Das *et al*. 2022). In Bangladesh, total quantity of soybean production was 0.064 million tones and occupied 0.041 million ha of land (BBS 2020).

In Bangladesh, one of the key factors limiting soybean yield is insect pest infestation, which causes an estimated 15–20% loss in production annually (Biswas 2008). Soybean plants are attacked by various pests, including aphids, looper pod borer, stem flies, bugs, whiteflies, leaf miners, jassids, and hairy caterpillars. Among them, the hairy caterpillar (*Spilarctia oblique*), leaf roller (*Lamprosema indicata*), cutworm (*Spodoptera litura*), pod borer (*Helicoverpa armigera*), stem fly (*Ophiomyia phaseoli*), and whitefly (*Bemisia tabaci*) are considered major pests due to their high population density and significant yield impact (Biswas 2013). Developing effective, eco-friendly, and economically viable pest management strategies requires detailed knowledge of pest species, their status, seasonal occurrence, and the nature of damage (Jayanthi *et al*. 1993). Although insecticides are widely used in crop production for their quick action, ease of use, and availability. The reliance on synthetic insecticides has led to several problems, including pest resistance, residue accumulation, resurgence of pest populations due to the loss of natural enemies, and harm to pollinators. Moreover, they pose serious risks to human health, the environment, and biodiversity (Rahaman and Prodhan 2007).

In that case, eco-friendly approaches such as Integrated Pest Management Tools can be a solution to minimize the effect of synthetic insecticides on non-target organisms as IPM tools are a combination of biological, cultural, mechanical, and chemical methods used in a coordinated way to control pests sustainably by minimizing harm to humans, beneficial organisms, and the environment.(Horowitz and Ishaaya 2004). Therefore, the present research work was undertaken to evaluate the effectiveness of some selected IPM tools for developing packages against the major insect pests of soybean and disseminate sustainable insect pest management technologies for optimizing the yield of soybean.

MATERIALS AND METHODS

Experimental design and cultivation of crop: The study was set in the field under the Department of Entomology, Gazipur Agricultural University (GAU), Gazipur during October 2024 to April 2025. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. A total of 18 plots was made and the unit plot size was 3 m × 2 m. The BU Soybean 2 was collected from the Department of Agronomy, GAU, Gazipur. Before planting the seeds were treated with Vitavex-200 @ 0.25% to prevent seeds from the attack of soil borne disease. The seeds were sown in continuous line placed at about 5 cm depth from the soil surface by maintaining a 30 cm distance from row to row. After the germination of seedling, thinning of seedling was done keeping the seedling at 6 cm distance from each plant to plant in a row. Intercultural operations were done as necessary**.**

Treatments and methods of application: Five treatments viz., Biomax 1.2 EC (Abamectin) @ 1.0 ml/L of water, Success 2.5% SC (Spinosad) @ 1.5 g/L of water, Biotrin (Matrine 0.5% AS) @ 1.5 ml/L of water, Bio BTK (*Bacillus thuringiensis kurstaki*) @ 1.0 g/L of water, Neem seed kernel extract (NSKE) @ 50 g/L of water and an untreated control (spray of tap water only) were evaluated on the basis of reduction in looper and pod borer infestation in soybean.

Mature seeds of neem were collected and grounded into powder. The powder was soaked in water @ 50 g/300 ml of water overnight. The mixture was filtered through nylon net and maintained the volume at 1000ml. The insecticide mixture in the spray machine was shaken well and covered spray by a knapsack sprayer. Before spraying, the spray machine was calibrated to find out the required quantity of spray material for 3 plots. During the entire cropping season, a total of 2 spray of insecticides was done, one was applied at 30 days after sowing during seedling stage and another was applied at 45 days after sowing during pod developing stage. The spraying was done early in afternoon to avoid bright sunlight and drift caused by strong wind and adverse effect on pollinating bees.

Data collection and analysis: Data were collected some pre-selected parameters, such as number of pests and natural enemy with crop growing season, rate of plant infestation by different pests, healthy and infested pods per plot by number and weight and yield of soybean. The cumulative yield per plot from total harvests was calculated and it was then expressed in MT/ha. The observations on the incidence of insect pests and their natural enemies were counted visually with the help of magnifying glass at 15 days interval recorded from their appearance on plants till harvest. The insect pests and natural enemies were identified through comparing specimens in museum as well as by relevant literature and photographs. Sample was taken from 2 rows randomly and then converted to 6 rows per plot (3 × 2 m^2) for expressing rate of plant infestation and number of arthropod pests per plot. For obtaining pod yield (MT/ha), the weights of healthy, infested, and total pods of all harvests were taken plot-wise. The yield of healthy, infested, and total pods obtained were transformed into pods yield in ton per hectare. The weight of infested pods was recorded from the total weight of the harvested pods for each plot and the percent yield loss was calculated. The economic analysis or Marginal Benefit Cost Ratio (MBCR) was calculated on the basis of total expenditure of the respective treatment along with the total return from that particular treatment (Ali *et al.* 1996). Data were analyzed by using SPSS software for analysis of variance. ANOVA was made by F variance test (Gomez and Gomez 1984) and the mean comparisons were performed by Tukey HSD posthoc statistics.

RESULTS AND DISCUSSION

The abundance and infestation rates of soybean looper: The abundance and infestation rates of soybean looper varied significantly across the tested IPM tools (Table 1). At 3 DAT, the lowest number of larvae was recorded in Success 2.5 SC (8.0±0.5) treated plot with 9.3±3.7% infestation rate, followed by Biotrin (abundance 10.1±2.0/plot and 17.8±5.0% infestation rate) treated plot. In contrast, the highest was observed in untreated control plot (abundance 21.8±1.3/plot and 33.6±4.2% infestation rate) followed by Biomax 1.2 EC (16.6±3.6%), NSKE (18.5±4.4%) and Bio BTK (18.5±4.3%) treated plots. Similarly at 7 DAT, Success 2.5 SC (7.5±1.1%) treated plot performed better, followed by Biotrin (16.0±0.7%) treated plots and the highest infestation rate was found in untreated control plots (33.8±1.8%) with abundance 21.5±1.1/plot. In align with the present study Swami *et al*. (2019) observed that Spinosad 45 SC at different concentrations had been found to reduce the larval population of soybean loopers significantly, resulted a larval reduction of 67.29%.

Table 1. Effect of different bio-rational insecticides against looper of soybean (BU soybean 2) grown during *Rabi* season 2024-25

Treatment	Number of looper/plot		Rate of plant infestation (%)	
	3 DAT	7 DAT	3 DAT	7 DAT
Biomax 1.2 EC	14.3±0.8 b	13.3±0.5 b	16.6±3.6 b	16.8±0.6 b
Success 2.5 SC	8.0±0.5 c	7.3±0.9 c	9.3±3.7 c	7.5±1.1 c
Biotrin	10.1±2.0 bc	10.5±0.3 bc	17.8±5.0 b	16.0±0.7 b
Bio BTK	13.1±0.6 b	13.2±1.3 b	18.5±4.3 b	17.6±1.0 b
NSKE	13.6±1.4 b	13.2±1.5 b	18.5±4.4 b	14.5±0.2 b
Untreated control	21.8±1.3 a	21.5±1.1 a	33.6±4.2 a	33.8±1.8 a

Means within a column followed by same letter(s) are not significantly different (P=0.05) according to Tukey HSD posthoc statistic at < 0.05.

Rate of pod infestation (n/n): The rate of pod infestation differed significantly as impacted by the tested IPM tools (Table 2). Significantly the highest number of healthy pods per plot (34.0±4.1) was obtained from Success 2.5 SC treated plot, followed by Biomax 1.2 EC (27.3±3.3), whereas the lowest was from untreated control plot (13.6±5.6). The highest number of infested pods per plot was recorded from untreated control (10.5±2.0) and the lowest was achieved from Success 2.5 SC (1.3±0.0) treated plot. Total number of pods per plant was maximum in Success 2.5 SC (35.3±4.1) treated plot and minimum in untreated control (24.0±5.6) plot. In similar manner, pod infestation rate resulted lowest in Success 2.5 SC and considerably high in control (43.8±1.5) and Bio BTK (26.5±1.3) treated plots (Table 2). In a study conducted by Mohanty *et al*. (2022) on chickpea, spinosad 45% SC was one of the most effective treatments, resulting in a reduction of 65.03% in larval population.

The highest percent of pod infestation reduction over untreated control plot was found in Success 2.5 SC (91.6% by n/n) treated plot followed by Biomax 1.2 EC (64.4% by n/n) treated plot. The lowest percent of pod infestation reduction over untreated control plot was found in NSKE treated plot (32.0% by n/n) followed by Bio BTK (39.5% by n/n) and Biotrin treated plots (53.4% by n/n) (Fig. 1). In a similar study, Tanzum *et al*. (2023) found that the highest percent of pod infestation reduction over untreated control was found in Tracer 45 SC (90.8% by n/n and w/w)

Table 2. Effect of different different bio-rational insecticides on rate of pod infestation (n/n) of soybean per plot (3 × 2 m^2) grown during *Rabi* season 2024-25

Treatments	No. of healthy pods/plant	No. of infested pods/plant	No. of total pods/ plant	Pod infestation%
Biomax 1.2 EC	27.3±3.3 b	5.0±1.1 b	32.0±3.3 a	15.6±0.9 c
Success 2.5 SC	34.0±4.1 a	1.3±0.0 b	35.3±4.1 a	3.7±0.3 d
Biotrin	25.6±4.9 b	6.6±0.6 b	32.3±4.9 a	20.4±1.2 bc
Bio BTK	20.3±2.4 bc	7.3±1.2 b	27.5±2.4 ab	26.5±1.3 b
NSKE	17.6±7.0 c	7.6±1.3 b	25.5±7.0 b	29.8±1.3 b
Untreated control	13.6±5.6 d	10.5±2.0 a	24.0±5.6 b	43.8±1.5 a

Means within a column followed by same letter(s) are not significantly different (P=0.05) according to Tukey HSD posthoc statistic at < 0.05.

treated plot followed by Biomax 1.2 EC (71.7% by n/n and 72.0% by w/w) treated plot. The lowest percent of pod infestation reduction over untreated control plot was found in NSKE treated plot (58.0% by n/n and 58.5% by w/w) followed by Bio BTK (64.8% by n/n and 65.2% by w/w) and Biotrin (65.8% by n/n and 66.2% by w/w) treated plots. The untreated control in another study by Sreekanth *et al*. (2015) showed a mean pod damage of 35.7% and a weight loss of 21.9%, whereas treated plots significantly lowed the damage and obtained higher yields.

Effect of bio-rational insecticides to non-target arthropods: Data in Table 3 represents the effect of different eco-friendly management approaches on the abundance of beneficial/non-target arthropods at the studied soybean fields. The highest number of ladybird beetle per plot was found in Biomax 1.2 EC treated plot (14.2±0.5) followed by untreated control (13.2±1.5). In case of abundance of syrphid fly per plot, the findings showed that the abundance of syrphid fly was ranging from 3.2±1.2 to 7.9±1.1 per plot. Regarding black ant, the highest abundance of black ant was found in untreated control plots (47.2±1.8) followed by Biotrin (46.0±0.8). The abundance of spider showed no variation among the treatments including untreated control plots which ranged from 3.42±1.1 to 4.86±1.3 per plot. The highest number of bees per plot was observed in Biomax 1.2 EC treated plot (2.2±0.2) which was statistically similar to NSKE treated plot (1.8±0.5), Biotrin (1.7±0.2), Success (1.6±0.8), untreated control (1.6±0.2) and Bio BTK (1.5±0.1) treated plot. According to Efad *et al*. (2021) Azadirachtin, Spinosad, and Abamectin

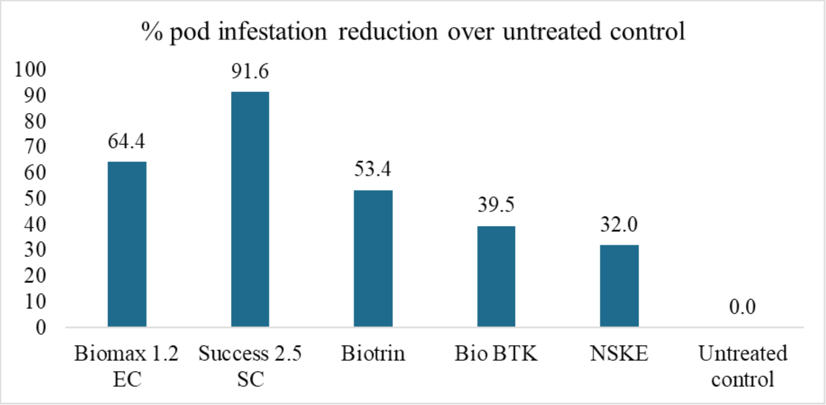

Fig. 1. Effect of different bio-rational insecticides on the rate of % pod infestation reduction over untreated control (n/n) by pod borers of soybean per plot (3 × 2 m^2) during *Rabi* season 2024-25.

were found to be bio-rational when beneficial arthropods such as ladybird beetles, syrphid flies, black ants, and spiders were present on the field over the whole brinjal season. In their investigation, the number of black ant and ladybird beetles showed the least statistical variation in the Spinosad and Abamectin treated plots compared to the untreated control plot, but no statistical variation was observed in the syrphid fly and spider populations among the treatments, including the untreated control.

Table 3. Effect of different bio-rational insecticides on abundance of beneficial arthropods per plot (3×2 m^2) during entire cropping season of soybean (Mean of 5 observations)

Treatments	No. of ladybird beetle/plot	No. of syrphid fly/plot	No. of black ant/plot	No. of spiders/plot	No. of bees/ plot
Biomax 1.2 EC	14.2±0.5 a	3.2±1.2 a	45.8±1.2 a	3.42±1.1 a	2.2±0.2 a
Success 2.5 SC	12.4±1.1 a	3.9±1.5 a	44.3±0.6 a	4.12±0.3 a	1.6±0.8 a
Biotrin	12.3±0.5 a	5.8±0.8 a	46.0±0.8 a	4.86±0.9 a	1.7±0.2 a
Bio BTK	11.6±0.7 a	4.1±0.8 a	43.0±1.4 a	4.86±1.4 a	1.5±0.1 a
NSKE	11.6±0.2 a	4.9±1.3 a	43.5±2.2 a	4.86±0.3 a	1.8±0.5 a
Untreated control	13.2±1.5 a	7.9±1.1 a	47.2±1.8 a	4.86±1.3 a	1.6±0.2 a

Means within a column followed by same letter(s) are not significantly different (P=0.05) according to Tukey HSD posthoc statistic at < 0.05.

Effect of bio-rational insecticides on yield of soybean: Tested treatment effects caused variation in yield and yield contributing parameters (Table 4). The highest 100-seed weight was obtained in Success 2.5 SC treated plot (24.5±1.4 g) which was statistically similar with Biomax 1.2 EC (22.7±1.1 g), Biotrin (22.4±1.7 g) and Bio BTK (20.3±1.3 g) treated plots. Significantly the lowest 100-seed weight was obtained in untreated control plot (16.8±1.8 g) which showed statistical similarity with NSKE treated plot (17.5±1.3 g). The highest yield (2.6±0.2 kg/plot) was obtained from Success 2.5 SC treated plot which was statistically similar to that of Biotrin (2.4±0.6 kg/plot) treated plot, Biomax 1.2 EC (2.4±0.1 kg/plot), Bio BTK (2.3±0.4 kg/plot), NSKE (2.0±0.4 kg/plot) and untreated control plot (1.4±0.2 kg/plot). The highest yield (4.4±1.1 MT/ha) was obtained from Success 2.5 SC treated plot which was statistically similar to that of Biotrin (4.0±1.1 MT/ha), Biomax 1.2 EC (4.0±1.3 MT/ha) and Bio BTK (3.8±1.1 MT/ha) treated plot. The lowest yield (3.3±0.8 MT/ha) was obtained from untreated control plot (3.0±0.8 MT/ha) which was statistically similar to that of NSKE treated plot (3.2±0.9 MT/ha) (Table 4). Spinosad 45 SC at a concentration of 0.01% was found to be highly effective in suppressing the larval populations of *Spodoptera litura* on soybean, resulting in a significant increase in grain yield of 13.46 q/ha compared to untreated control (Raut *et al*. 2019).

The highest percent increase of yield over untreated control (47.7%) was recorded in plot treated with Success 2.5 SC followed by 34.5% in Biotrin and 33.3% in Biomax 1.2 EC treated plots. The lowest percent increase of marketable

Table 4. Effect of different bio-rational insecticides on yield of soybean (MT/ha) grown during *Rabi* season 2024-25

Treatment	100-seed weight (g)	Yield (kg/plot)	Yield (MT/ha)
Biomax 1.2 EC	22.7±1.1 ab	2.4±0.1 a	4.0±1.3 a
Success 2.5 SC	24.5±1.4 a	2.6±0.2 a	4.4±1.1 a
Biotrin	22.4±1.7 ab	2.4±0.6 a	4.0±1.1 a
Bio BTK	20.3±1.3 ab	2.3±0.4 a	3.8±1.1 ab
NSKE	17.5±1.3 bc	2.0±0.4 a	3.3±0.9 b
Untreated control	16.8±1.8 c	1.4±0.2 a	3.0±0.8 b

Means within a column followed by same letter(s) are not significantly different (P=0.05) according to Tukey HSD posthoc statistic at < 0.05.

yield over untreated control was found from NSKE treated plot (10.0%) followed by Bio BTK (26.7%) treated plots (Fig. 2).

Economic analysis of different IPM tools: The details of the cost of pest management (Tk./ha) under tested IPM tools against insect pests in soybean grown during *Rabi* season 2024-25 are presented in Table 5. Management cost was the highest (Tk. 12910.0) with Success 2.5 SC followed by Biomax 1.2 EC (Tk. 9920.0) and Biotrin (Tk. 9408.0). The lowest management cost (Tk. 2320.0) was found in untreated control plot followed by Tk. 5500.0 with NSKE and Tk. 8212.0 with Bio BTK (Table 5). The highest gross return (Tk. 220000.0) was found with Success 2.5 SC followed by Tk.200000.0 in Biomax 1.2 EC and Biotrin. The lowest gross return (Tk. 150000.0) was found in untreated control, followed by NSKE (Tk. 165000.0) and Bio BTK (Tk. 190000.0) treated plot. The highest net return (Tk. 207090.0) was recorded from Success 2.5 SC followed by Tk. 190592.0 in Biotrin, Tk. 190080.0 in Biomax 1.2 EC, Tk. 177090.0 with Bio BTK, Tk. 156788.0 with NSKE and the lowest Tk. of 147680.0 in untreated control. The highest adjusted net return (Tk. 59410.0) was recorded in Success 2.5 SC followed by Tk. 42912.0 from Biotrin and Tk. 42400.0 from Biomax 1.2 EC treated plot. The lowest adjusted net return was calculated from NSKE (Tk. 9108.0) followed by Bio BTK (Tk. 29410.0) whereas untreated control had no adjusted net return (Table 5).

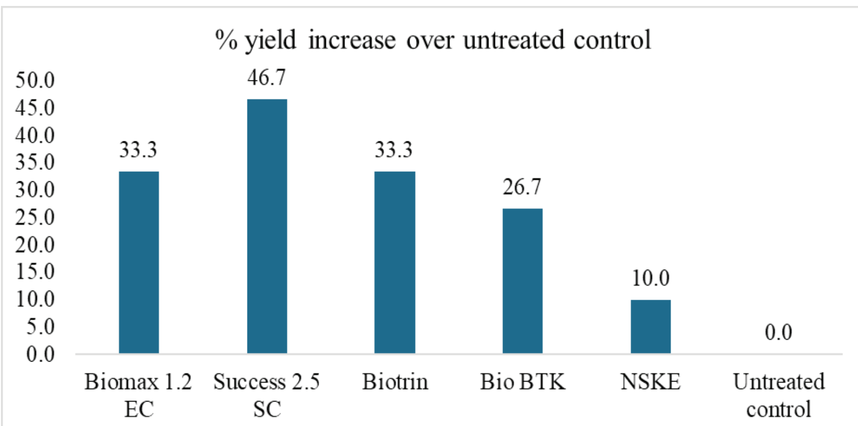

Fig. 2. Effect of different bio-rational insecticides on % yield increase over untreated control of soybean during *Rabi* season 2024-25.

Table 5. Marginal benefit cost ratio (MBCR) analysis of selected IPM tools against arthropod pests in soybean (MT/ha) grown during *Rabi* season 2024-25

Treatments	Management cost (Tk)	Gross return (Tk)	Net return (Tk)	Adjusted net return (Tk)	MBCR
Biomax 1.2 EC	9920.0	200000.0	190080.0	42400.0	4.2
Success 2.5 SC	12910.0	220000.0	207090.0	59410.0	4.6
Biotrin	9408.0	200000.0	190592.0	42912.0	4.5
Bio BTK	12910.0	190000.0	177090.0	29410.0	2.2
NSKE	8212.0	165000.0	156788.0	9108.0	1.1
Untreated control	2320.0	150000.0	147680.0	0.0	-

Market value of soybean= 50.0 Tk./kg, cost of Biomax 1.2 EC per spray= 3800.0 Tk/ha, Success 2.5 SC per spray= 5295.0 Tk/ha, Biotrin per spray= 3544.0 Tk/ha, Bio BTK per spray = 5295.0 Tk/ha, Neem seed kernel extract per spray = 2946.0 Tk/ha, Labor cost= 550 Tk/day, No. of spray=2, sprayer rent= 30 Tk/day.

The highest MBCR of 4.6 was obtained from the plot treated with Success 2.5 SC followed by 4.5 in Biotrin, 4.2 in Biomax 1.2 EC and 2.2 in Bio BTK sprayed plots. The lowest marginal benefit cost ratio (1.1) was found from the NSKE treated plot (Table 5).

Alam *et al*. (2021) found that the highest benefit cost ratio (12.81) estimated for Voliam Flexi (Thiamethoxam + Chlorantraniliprole) @ 0.25ml/L of water at 10 days interval and the lowest (4.16) for Allion 2.5 EC (Lamda-Cyhalothrin) @ 2.0 ml/L of water at 10 days interval. The highest BCR found in the treatment with Voliam Flexi, which may be due to the minimum pest infestation compared to the other treatment components and resulted the better yield. In a similar study, Tanzum *et al*. (2023) found the highest MBCR of 3.02 from the plot treated with Tracer 45 SC followed by 2.37 with Biomax 1.2 EC, 1.99 with Bio BTK and 1.88 with Fytomax PM sprayed plots. The lowest marginal benefit cost ratio (1.60) was obtained from the NSKE treated plot.

CONCLUSION

Management approach comprising of two sprays of Success 2.5 SC @ 0.4 g/L of water at 15 days interval might be an effective, suitable and viable approach for suppressing looper and pod borer in soybean field.

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